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To: Instrumentation Laboratory Personnel
From: D. G. Hoag
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Subject: How Did We Do on Apollo 9?

The most complex Apollo mission yet, Apollo 9, was launched 3 March 1969, on a tremendously successful 10-day earth orbital flight which included the first manned operations with the lunar module spacecraft. The guidance, navigation, and control systems both in the command module and in the lunar module were used in accomplishing the many tests and maneuvers needed to demonstrate capability for landing on the moon.

The major event of the flight was the rendezvous of the lunar module with the command module. These exercises just had to succeed for the lunar module crew to return safely to earth. While McDivitt and Schweickart in the lunar module, using data from the rendezvous radar and the inertial measurement unit, were performing rendezvous navigation with programs in the LM flight computer, Scott in the command module was tracking the lunar module with the optics, using this information and his inertial measurement unit to perform rendezvous navigation in his computer. And the ground tracking network was generating a third solution. All three agreed closely. The various maneuvers were performed by the lunar module as planned using the LM on-board generated solutions.

Eight firings of the service propulsion system were performed by the CM system; two descent, and two ascent engine firings were performed by the LM system. These included several docked burns with the command and service module pushing the lunar module and a six-minute long descent engine test while the lunar module pushed the command and service module. This was the first opportunity to observe the digital autopilots in each vehicle in controlling the docked configuration which exhibits a significant destabilizing effect of low frequency flexure and fuel slosh. They worked fine.

Although it did not interfere with any mission objective, the first in-flight GN&C hardware failure occurred early in this mission. A tiny pin weighing less than one one-thousandths of an ounce got dislodged from the scanning telescope shaft angle counter rendering the counter useless. This mechanical counter is a backup to the normal readout of that angle on the computer display. The telescope itself was sticky for a while but was put into operation by freeing it with the manual tool provided. No further

problems with the telescope occurred. It still functioned as required later in the flight. The counter design had passed extensive qualification testing with no trouble with the offending pin. Fortunately, the failure was innocuous.

Two interesting tests with the computer controlled optics were performed. Taking data from an on-board chart Scott used the DSKY to load the celestial coordinates of Jupiter into the computer and using alignment program P52 asked the computer to point the optics at the planet. He was rewarded with a fine display of Jupiter and her moons in the 28 power sextant. Then he used this sighting on Jupiter to realign the inertial measurement unit in a demonstration of a backup alignment mode using planets.

Later, several days after the rendezvous operations, the ground tracking system sent up to the crew the orbital parameters of the lunar module which had been sent away alone into high apogee with a controlled fuel depletion burn of the ascent engine. The computer in rendezvous program P20 used this information and its knowledge of the command module motions to point the sextant at where it expected the lunar module. And there it was. Scott picked it up in the eyepiece 2700 nautical miles away and was able to keep track for some time before it was blocked from view.

The great flexibility of the GN&C with the computer controlled interconnection of sensors, processors, and effectors is clearly evident.

The splashdown of Apollo 9, right in the target area in sight of the recovery carrier, was witnessed by a fascinated T. V. audience.

The GN&C has now logged over 400 hours of in-flight operation. Every mode of guidance, navigation, and control that is needed for the lunar landing and can be performed without actually landing has been demonstrated with required or better performance. More operational experience near the moon will be obtained in Apollo 10 next month before the landing with Apollo 11 is attempted in August,

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